it amounted to 10+1 or 11 days, because the year 1700 was a leap year in the old style but not the new. These procedures of changing the intercalation of leap years and dropping 10 days were simple enough, but problems arose concerning the change required in the lunar cycle

1582 CAL. (I)

ENCYC BRITTANICA 1971

Gregory XIII was advised in his reformation by the Neapolitan astronomer and physician ALOYSIUS LILIUS or LUIGI LILIO GHIRALDI. BUT LILIUS died in 1576, before the reformation was fully completed, and Gregory then sought the assistance of the German Jesuit and mathematician CHRISTOPHER CLAVIUS (1537-1612), who verified all the calculations and developed the rules. ... CLAVIUS published his ROMANI CALENDARII a GREGORIO XIII P.M. RESTITUTI EXPLICATIO in 1603

The first thing to do was to take account of the fact that the tropical year amounts to 365.2422 and not 365.25 days. This difference amounts to 3 days in 128 x 3 or 384 years (actually 384.616 yrs.) i.e. to approx. 3 days in 400 yrs; and it was this approximation which Gregory adopted. Gregory ordered that no Century year should be counted as a leap year unless it was exactly divisible by 400. By the time this reformation took place the displacement of the vernal equinox had increased to 10 days, so Gregory directed that the day following the feast of St. Francis i.e. Oct. 5 should be reckoned as Oct. 15.

i.e. Oct 4; ~~Oct 5~~; Oct 15, Oct 16 etc

In consequence the next vernal equinox fell correctly on Mar. 21 instead of on Mar. 11

Vernal equinox 1582 — Mar 11, 1582
Vernal equinox 1583 — Mar. 21, 1583

The difference between the Gregorian Cal. (new style) and the Julian Cal. (usually referred to after this reformation as old style) remained 10 days until the year 1700, after which

intercalary day would result in the astronomical new moon occurring one day later in every month following such omission. Thus the age of the new moon would be one day less at the end of every such month. Therefore, it was necessary that the EPACT should be diminished by unity, and so the epacts 11, 22, 3, 14 etc. would become 10, 21, 2, 13, etc. On the other hand the lunar cycle was not exact; the error amounted to one day in a little over 307 yrs, the astronomical new moon arriving

(II)

EPACTS - It was LILIUS who tackled this problem of changing the lunar cycle. It amounted to 6939.75 days whereas the true period for 235 lunations should have been $235 \times 29.530588 = 6939.68818$ days. Because a lunar cycle covers 19 Julian years, the difference of 0.06182 days amounts to one whole day in a little over 307 years and so, after this period the new moons occur one day earlier than indicated by the golden numbers. For the reform it was decided to reject the golden numbers and adopt the "EPACT".

(This term was derived from the Greek EPAKTE and meant, originally, an intercalation, but was later used to signify the age of the moon at the beginning of the year. Now the difference between the calendar year and the lunar year is 365 - 354 or 11 days; and therefore if a new moon falls, for ex. on Jan. 1 in one year, it will be 11 days old on Jan. 1 of the next year and 22 days old on Jan. 1 of the year after that. The EPACT of the second year is then said to be 11 and of the third year 22. HOWEVER, LILIUS gave every third yr of the lunar cycle an intercalary month of 30 days; therefore, in the fourth year the age of the moon on Jan 1 would be not 33 days but only 3. It might, therefore, appear that to find the epact for any calendar year, 11 should be added to the epact of the previous year and when the sum exceeds 30, deduct 30. However, the problem of leap years and the above-mentioned irregularity of the lunar cycle have to be taken into account.

The omission of a leap yr every century except when the date was exactly divisible by 400 meant that the omission of the

of the epact is to indicate the age of the moon at the beginning of a year, it is clear that, in the course of time, the epact will have values ranging from 1 to 30 inclusive to correspond with the days in a full lunar month. TO COMPUTE THE EPACT THE LAST DATE OF THE LAST LUNATION OF THE PREVIOUS YEAR IS TAKEN; THIS SHOWS THE DATE OF THE LAST NEW MOON IN THE YEAR AND THUS THE AGE OF THE MOON ON THE LAST DAY OF THAT YEAR IS FOUND

(III)

one Cal. day earlier. This required an increase of the EPACT by unity so that epacts 11, 22, 3, 14 etc. became 12, 23, 4, 15 etc. What was subtracted in order to bring matters into line through more accurate intercalation had largely to be added on again to allow for errors in the lunar cycle, and it was therefore decided that any change in the EPACT which might be required should be held in abeyance until the commencement of the appropriate century. Correction of the EPACT for errors in the lunar cycle were to be made only at the end of 300 yrs. and in the

the Gregorian cal. this correction was assumed, for convenience to amount to one day in 312 1/2 years or 8 days in 2,500 years. These changes of EPACT were made at the end of seven successive 300-yr periods and once at the end of a 400-yr period. From the way in which the epacts were disposed at the time of the reformation of the Cal. it was found that the most correct result was to be obtained by assuming one of the 2,500-yr periods to terminate with the year 1800. Reckoning from the time of the Gregorian reform,

the correction of the epact for intercalation occurs in the years 1700, 1800, 1900, 2100 2200, 2300, 2500 etc. and that for the lunar cycle in 1800, 2100, 2400, 2700, 3000, 3300, 3600 etc. In the former instance the EPACT is diminished by unity. In the latter it is augmented by unity. When the changes coincide, as they do in the years 1800 and 2100, [illegible] no changes in EPACT are made.

In the light of the above, epact numbers can be so calculated as to minimize calendar errors. Because the purpose

were so arranged that there was no chance for the Paschal full moon to coincide with the Jewish Passover.

Introduction of the Gregorian Cal. also involved a change in the dominical letters because of the omission of an intercalary day every 100 years; this change makes it possible to use the dominical cycle throughout a century.

IV

THE MOON'S AGE IN DAYS IS THE EPACT OF THE NEXT YEAR.

FOR EX. If the last lunation ends on Dec. 2, then the last new moon falls on Dec. 3, and so the age of the moon on Dec 31 is 31 - 2 or 29 days. The EPACT of the year following is therefore 29. Similarly, if the last lunation of the year had occurred on Dec. 3, the epact of the year following would have been 28. This computation will only be altered if the new year to which the EPACT applies is 1700,

1800, 1900, 2100 etc. If it is 1700 then the epact is 29-1 or 28 because of intercalation; if it is 1800 the epact is 29-1+1 = 29 owing to the intercalation and the correction for the lunar cycle. In 1900 intercalation makes the epact 28 again; in 2100 the double correction will leave 29 once again unaltered.

The principal use of the epact is in determining Easter, the date of which is regulated by the moon's age as given by the EPACT, with the

vernal equinox taken as occurring on Mar. 21. Even the Gregorian Cal. is not exact and the vernal equinox can be as much as two days early, so that a full moon may occur after the true equinox but still before the Calendar equinox (MARCH 21); Thus the ingenious but complicated system invented by LILIUS meant that the date of Easter could be determined without reference to astronomical observations solely by the correct use of tabulated values. Moreover the EPACTS

(V)

The Orthodox Church in Greece adopted the Gregorian Cal. with a 900-year cycle, but computes the date of Easter by means of the moon's actual movements rather than the simplified assumptions of the ecclesiastical Cal., basing its calculations on the meridian of Jerusalem.

Later, a slight change was made in the Gregorian Cal. to

bring it still more closely into
line with the tropical year.
The Gregorian Cal. is still in error
by one day in 3,323 years and in
consequence, a further rule of
intercalation has been adopted
that makes the years 4000, 8000,
etc. Common years, i.e years
without an intercalated day.
The calendar is now therefore
correct to within one day
in 20,000 years.

1582

THE JULIAN YEAR OF 365¼ DAYS WAS LONGER THAN THE SOLAR YEAR BY 11 MIN, 14 SEC. THE ERROR THEREFORE AMOUNTED TO A DAY IN 128 YEARS, AND IN A FEW CENTURIES THE VERNAL EQUINOX HAD FALLEN BEHIND THE JULIAN CALENDAR BY SEVERAL DAYS.

IN 1582 WHEN POPE GREGORY XIII WITH THE AID OF ALOYSIUS

LILIUS, UNDERTOOK THE REFORMATION OF THE JULIAN CALENDAR, THE 11 MIN 14 SEC ERROR AMOUNTED TO MORE THAN 10 DAYS GREGORY SUPPRESSED 10 DAYS, CALLING OCT 5, 1582 = OCT 15, 1582 AND RULED:

EVERY YEAR DIVISIBLE BY 4 TO BE A BISSEXTILE OR LEAP YEAR CONTAINING 366 DAYS.

EVERY SECULAR YEAR 1600, 1800 1900, 2000, IF DIVISIBLE BY 400 TO BE A BISSEXTILE OR 366-DAY YEAR, BUT IF NOT SO DIVISIBLE TO HAVE ONLY 365 DAYS

UNDER THE GREGORIAN CALENDAR THERE IS STILL A SLIGHT ERROR BUT IT ONLY AMOUNTS TO ONE DAY IN 3866 YEARS.